

SEMI C3.57-0600

SPECIFICATION FOR CARBON DIOXIDE, CO₂, ELECTRONIC GRADE IN CYLINDERS

This specification was technically approved by the Global Gases Committee and is the direct responsibility of the European Gases Committee. Current edition approved by the European Regional Standards Committee on April 4, 2000. Initially available at www.semi.org May 2000; to be published June 2000.

1 Description

1.1 Carbon dioxide is a non-flammable, colorless, odorless, slightly acidic gas which is stable under normal conditions.

2 Specifications

Purity: 99.999%

Impurities	Maximum Acceptable Level
Nitrogen	4 ppm
Oxygen	1 ppm
Methane	0.5 ppm
Moisture	2 ppm

3 Referenced Standards

3.1 DIN Standard¹

DIN 50457-1

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

4 Physical Constants (for information only)

Formula	CO ₂
Molecular weight	44
Melting point	-56.6°C
Boiling point	-78.5(s)°C
Critical temperature	30°C
Relative density, gas	1.52 (air=1)
Relative density, liquid	0.82 (water=1)
Vapor pressure 20°C	57.3 bar
Appearance/Color	Colorless gas
Odor	none

5 Analytical Procedures

5.1 *Nitrogen, oxygen and methane* — This procedure is for the determination of nitrogen, oxygen and methane using a gas chromatograph with discharge ionization detector and heartcut column switching.

5.1.1 Detection Limit — 100 ppb.

¹ Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Burggrafenstrasse 4-10, D10787 Berlin, Germany, www.din.de

5.1.2 Instrument Parameters

5.1.2.1 Columns

Column 1: Hayesep Q, 2 meters by 3 mm (Stainless-steel or nickel rich alloy).

Column 2: Molecular sieve 5A, 3 meters by 3 mm (Stainless-steel or nickel rich alloy) 80/100 mesh or equivalent.

5.1.2.2 Carrier Flow: 25 mL/minute helium.

5.1.2.3 Sample Volume: 2 mL.

5.1.2.4 Temperatures:

Detector	110°C
Column Oven	50°C
Injector	Ambient

5.1.3 Calibration Standard — 1–10 ppm (mole/mole) nitrogen, oxygen and methane, balance helium.

5.1.4 Operating Procedure

5.1.4.1 Inject the calibration standard into the gas chromatograph via the gas sampling valve. Record the retention times and peak areas for the components within the standard. The order of elution is: oxygen, nitrogen, methane.

5.1.4.2 Inject the sample to be tested in the same manner as the calibration standard. Record the retention times and peak areas. The carbon dioxide matrix gas is vented via the heartcut.

5.1.4.3 Repeat 5.1.4.1.

5.1.4.4 Compare the average peak areas of the calibration standard to that of the unknown carbon dioxide sample being tested. Calculate the concentrations of oxygen, nitrogen and methane using the formula below. The results shall not exceed the values specified in Section 2 of this standard.

$$\frac{\text{Sample Peak Area}}{\text{Standard Peak Area}} \times \frac{\text{Concentration}}{\text{Standard}} = \frac{\text{Concentration}}{\text{Sample}}$$

5.2 *Moisture* — This procedure is for the determination of moisture in carbon dioxide using a direct readout moisture analyzer with a phosphorus pentoxide electrolytic cell.

5.2.1 *Detection Limit* — 100 ppb.

5.2.2 *Instrument Parameters*

5.2.2.1 *Flow requirements* — Zero and span the analyzer in accordance with the instrument manufacturers instructions. Set the sample gas flow to the rate specified by the manufacturer.

5.2.3 *Calibration standard* — The analyzer shall be calibrated at the time of use by reference to a standard gas calibration mixture containing a certified moisture content close to the expected value of the gas under test. If the analyzer indicates the certified moisture content, within the overall measurement uncertainties stated by the instrument and gas manufacturers, it may be used without further adjustment or calibration.

NOTE 2: Further Experimental detail may be found in DIN 50450-1.

5.2.4 *Sample system*

5.2.4.1 Use insulated stainless steel sample lines to prevent frosting during sampling.

5.2.4.2 Keep sample lines to a minimum length.

5.2.5 *Operating Procedure*

5.2.5.1 Follow the procedures specified in the instrument manufacturer's manual.

5.2.5.2 Allow the system to run until a stable reading is obtained for 5 minutes.

5.2.5.3 Read and record the concentration of moisture, in ppm, indicated on the moisture analyzer. The result obtained shall not exceed the value specified in Section 2 of this standard.

NOTE 3: This specification applies to gaseous phase product from a cylinder supply.

NOTE 4: It is recommended that the user discontinue use of the cylinder prior to the complete consumption of the liquid phase contents. The contents of cylinders containing liquefied product should be determined by weight and not pressure.

NOTE 5: Adopt a replicate sampling protocol for both calibration standard and unknown to achieve the required measurement uncertainty.

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